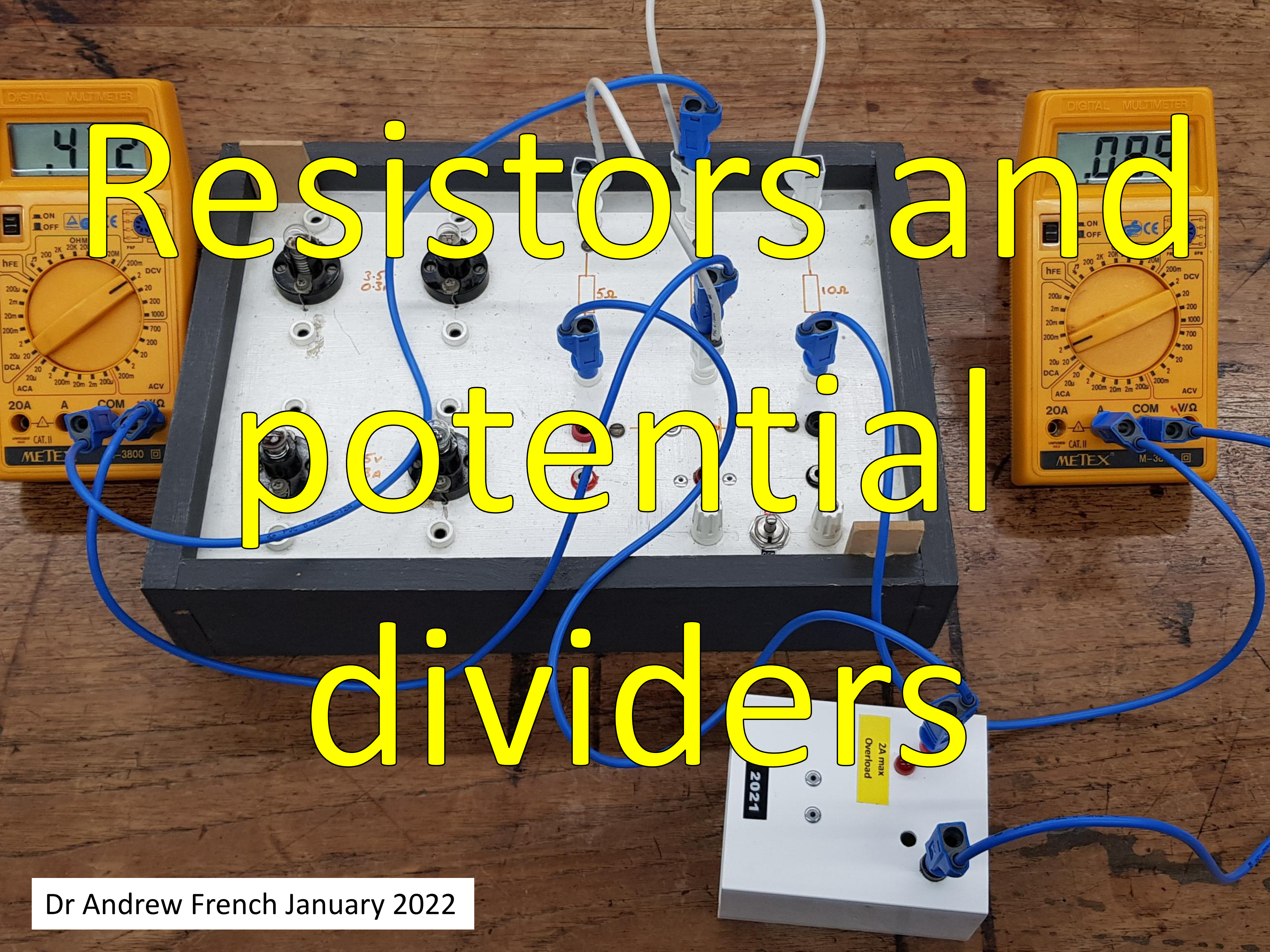
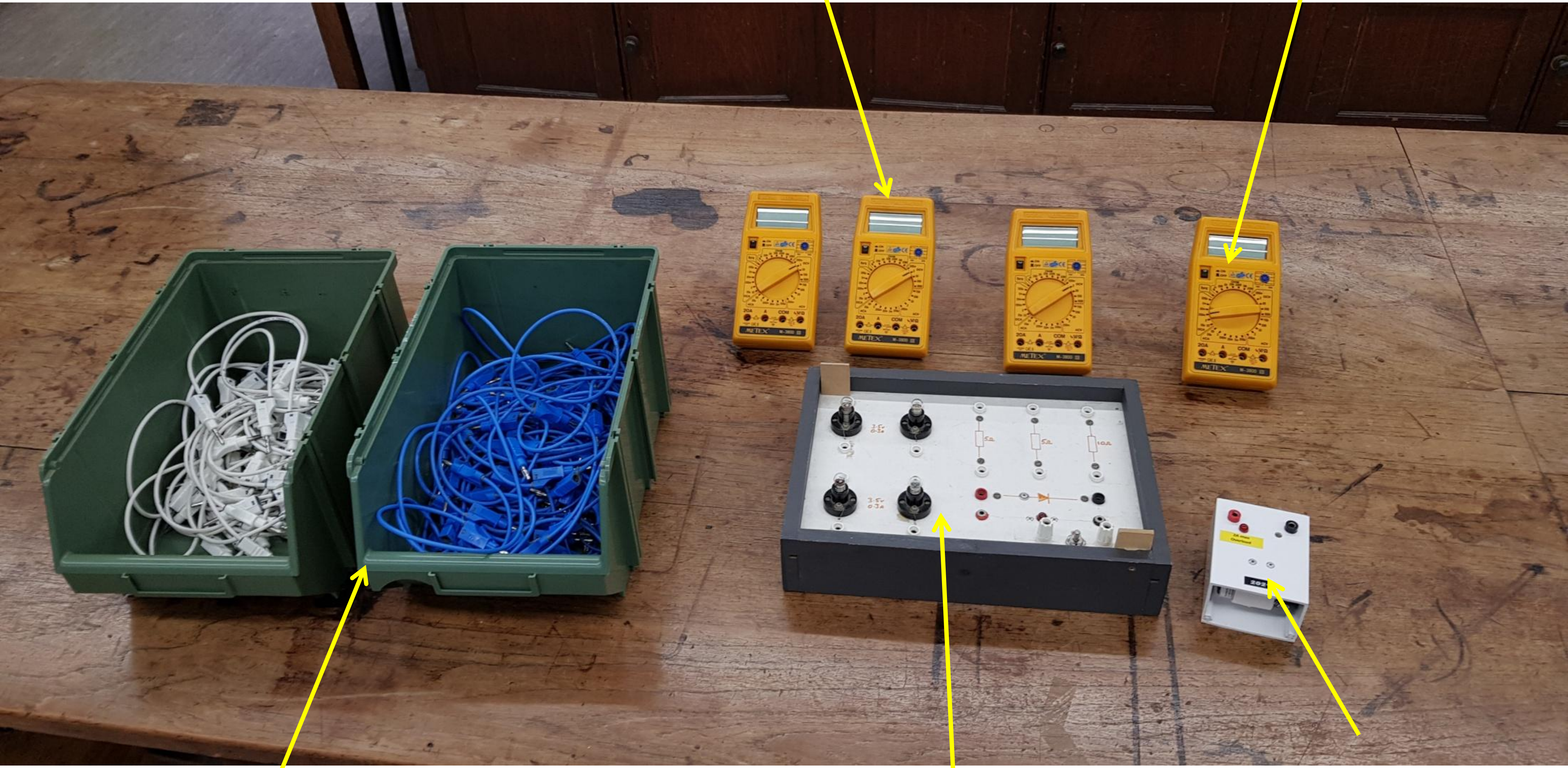
Resistors and potential dividers



Dr Andrew French January 2022

Equipment

Multimeters (we'll use one as a VOLTMETER and one as an AMMETER)

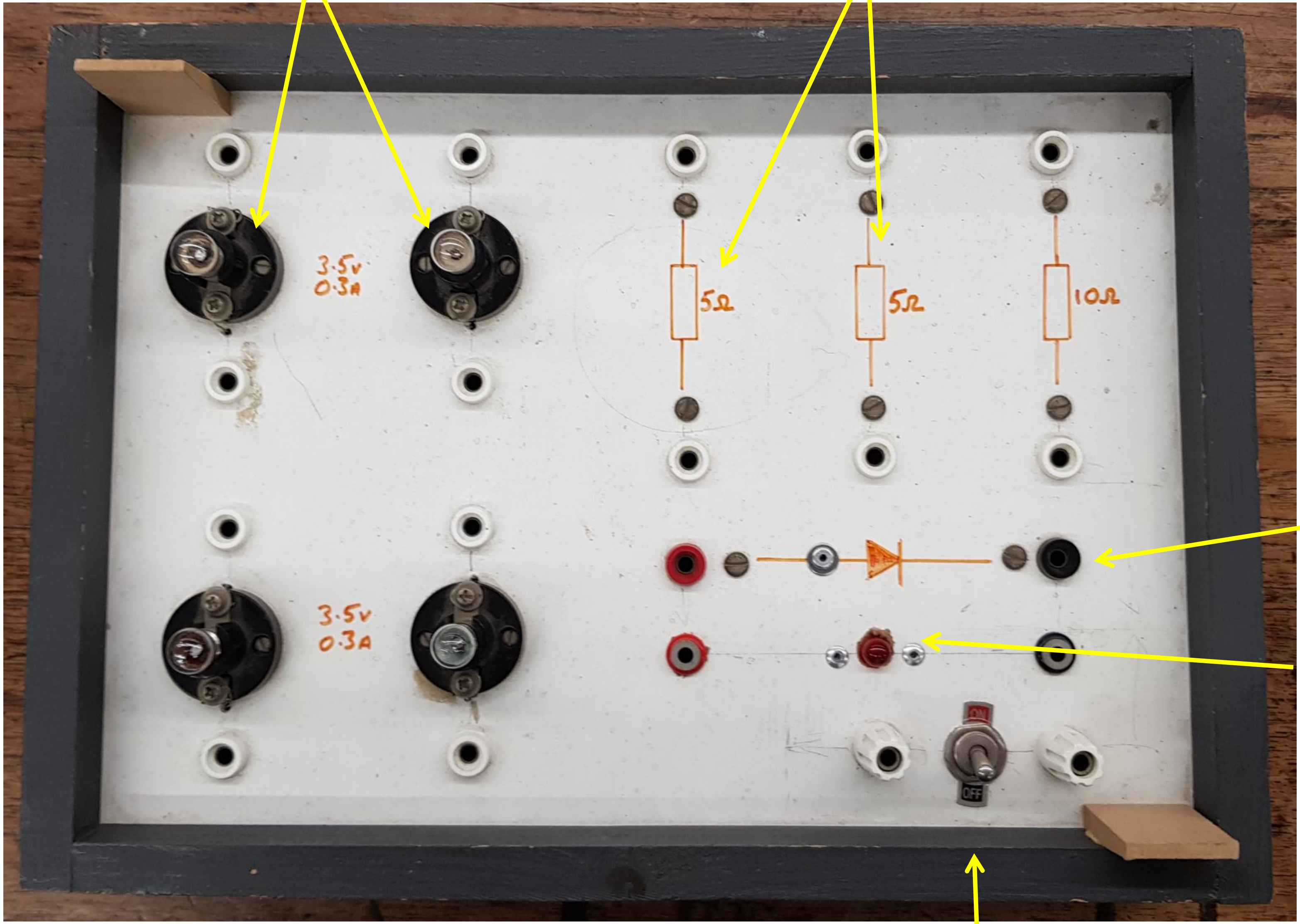


Lots or wires!

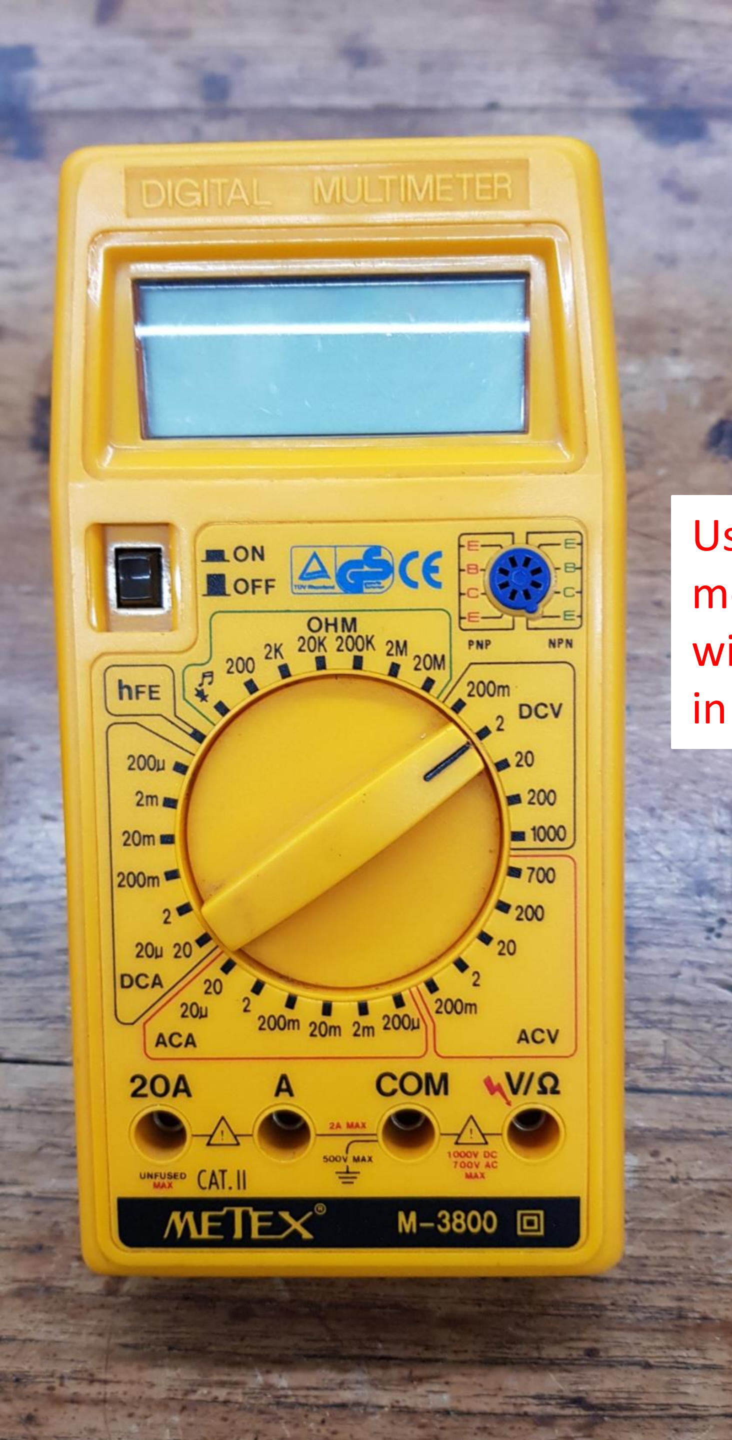
Resistor, bulb and diode circuit board

2V DC cell

ALWAYS SET UP A MULTIMETER <u>BEFORE</u> YOU WIRE IT INTO A CIRCUIT.
AN *AMMETER* USED AS A *VOLTMETER* WILL CAUSE IT TO BLOW A FUSE.



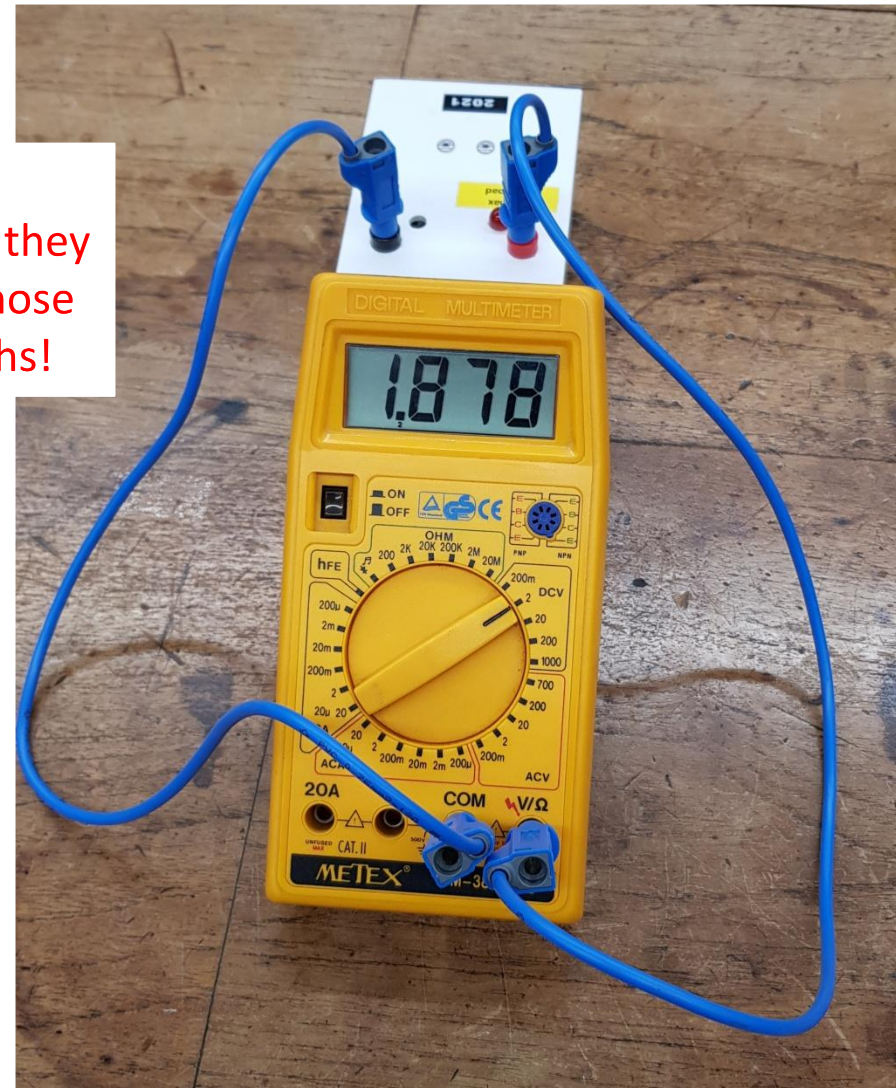
Don’t expect the resistors to be *exactly* 5ohms or 10ohms!

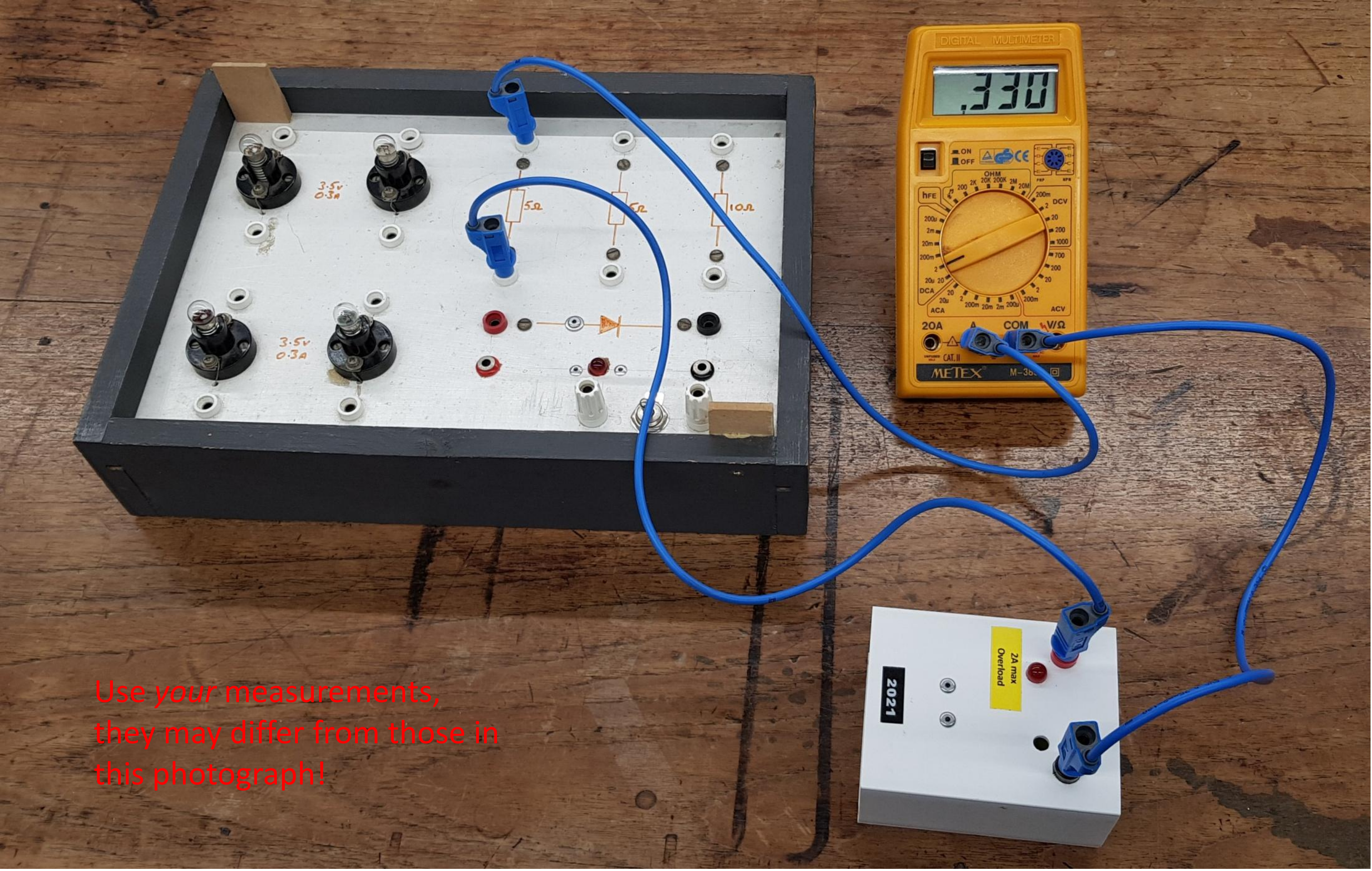


1. Set one of the multimeters as a **DC VOLTMETER** (**DCV** region of the dial). Connect **V** and **COM** across the cell and measure the voltage.

CELL VOLTAGE = ...

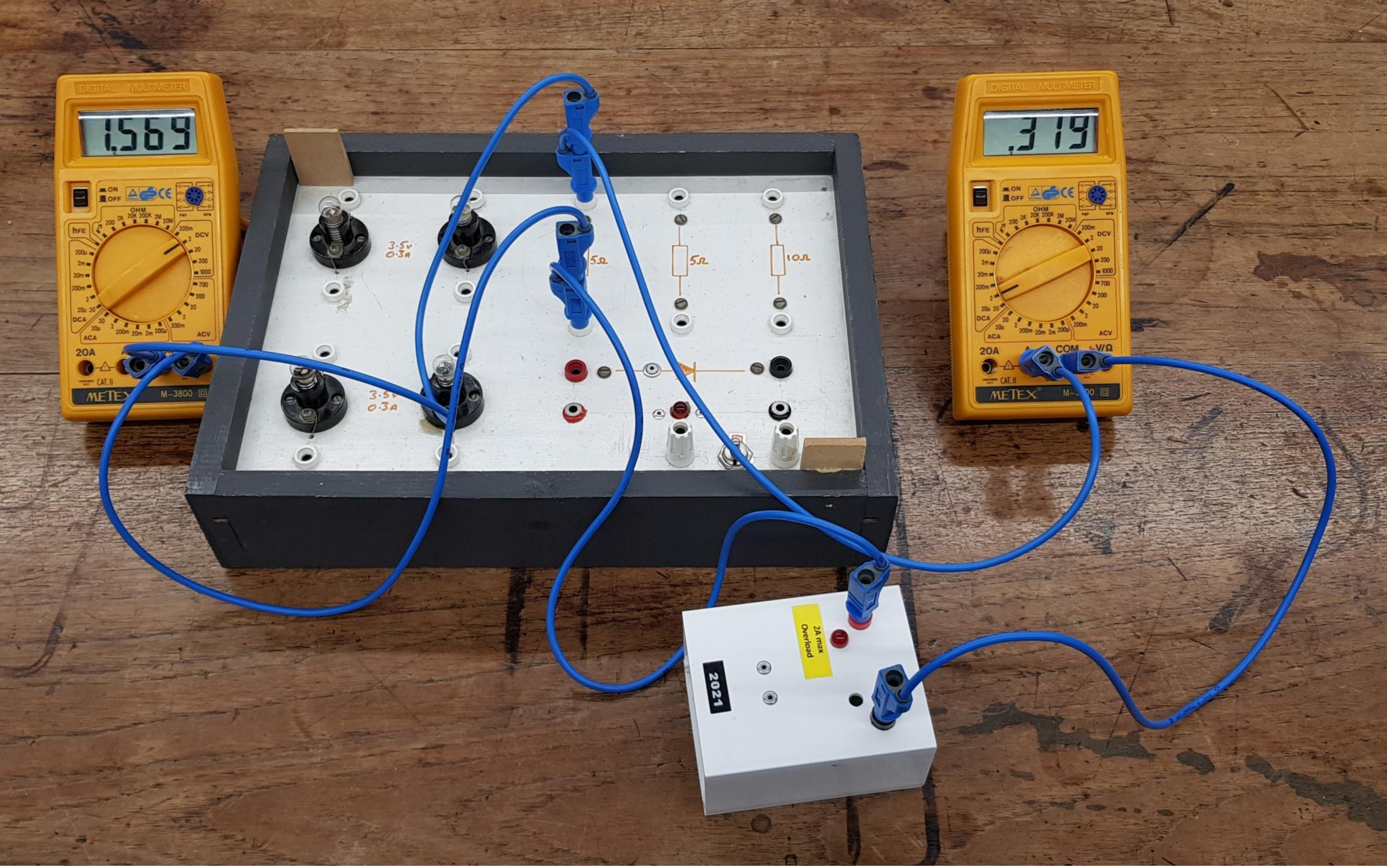
Use you own measurements – they will differ from those in the photographs!





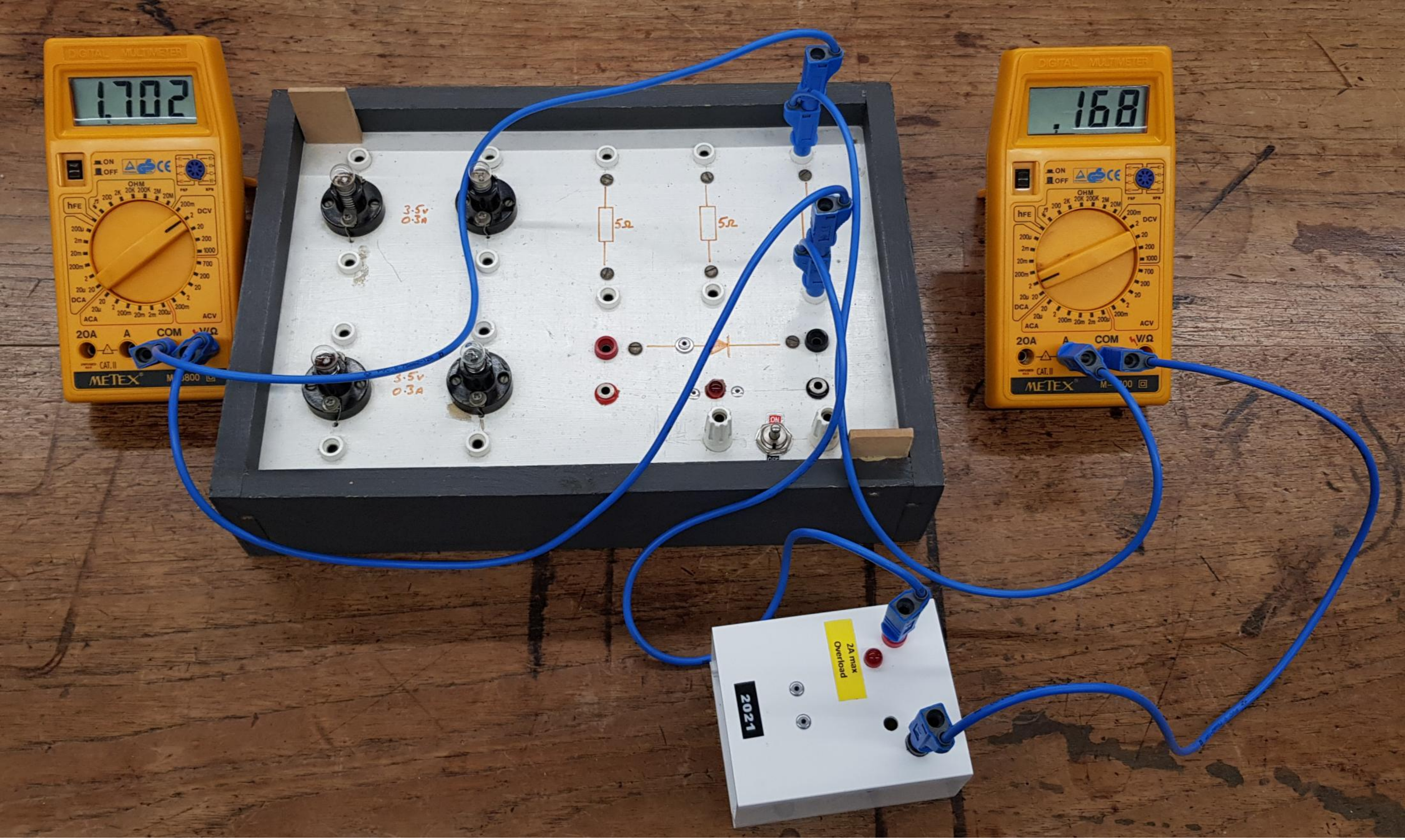
2. Set a (second) multimeter in **DCA (DC ammeter) mode**. A scale of ‘up to 2A’ should be sufficient. Wire in a **series loop** with the cell and the *first* ‘5ohm’ resistor.

CIRCUIT CURRENT = ...



3. Connect the multimeter in **DCV** mode *in parallel **across** the resistor*. Calculate the **resistance** (to 3.s.f) using $R = V / I$. V = ... I = ... R = ...

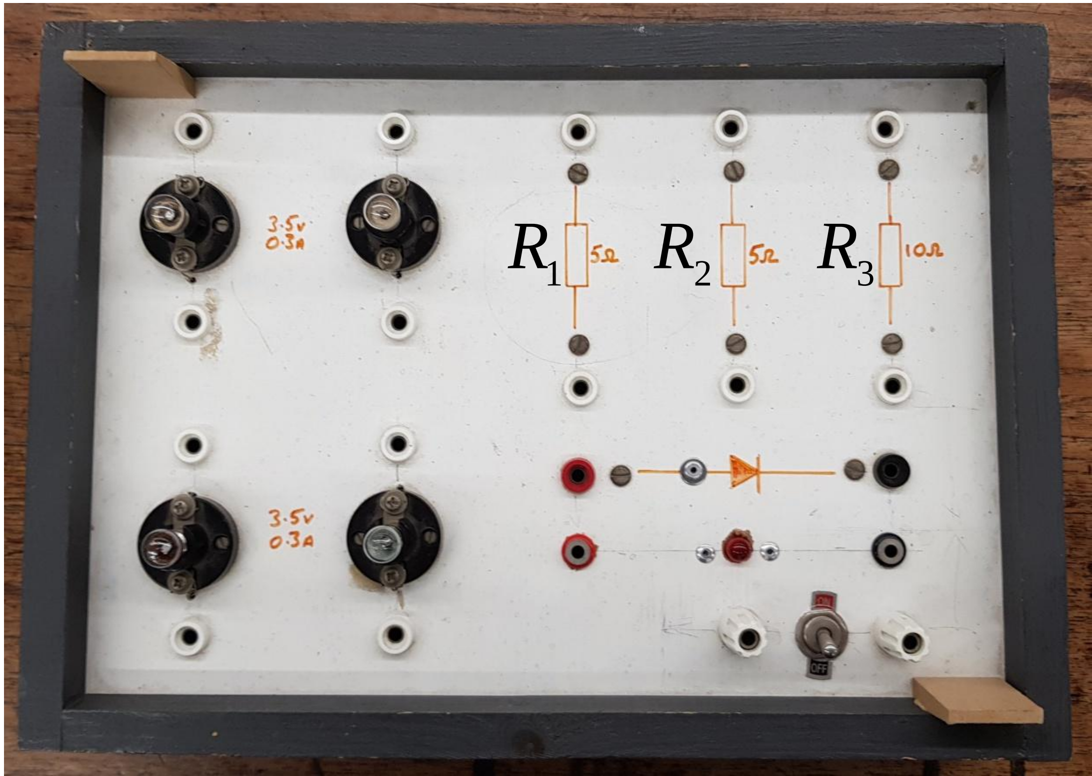
4. Connect the multimeter in **DCV** mode *in parallel **across** the **second** resistor*. Calculate the **resistance** (to 3.s.f) using $R = V / I.$ V = ... I = ... R = ...

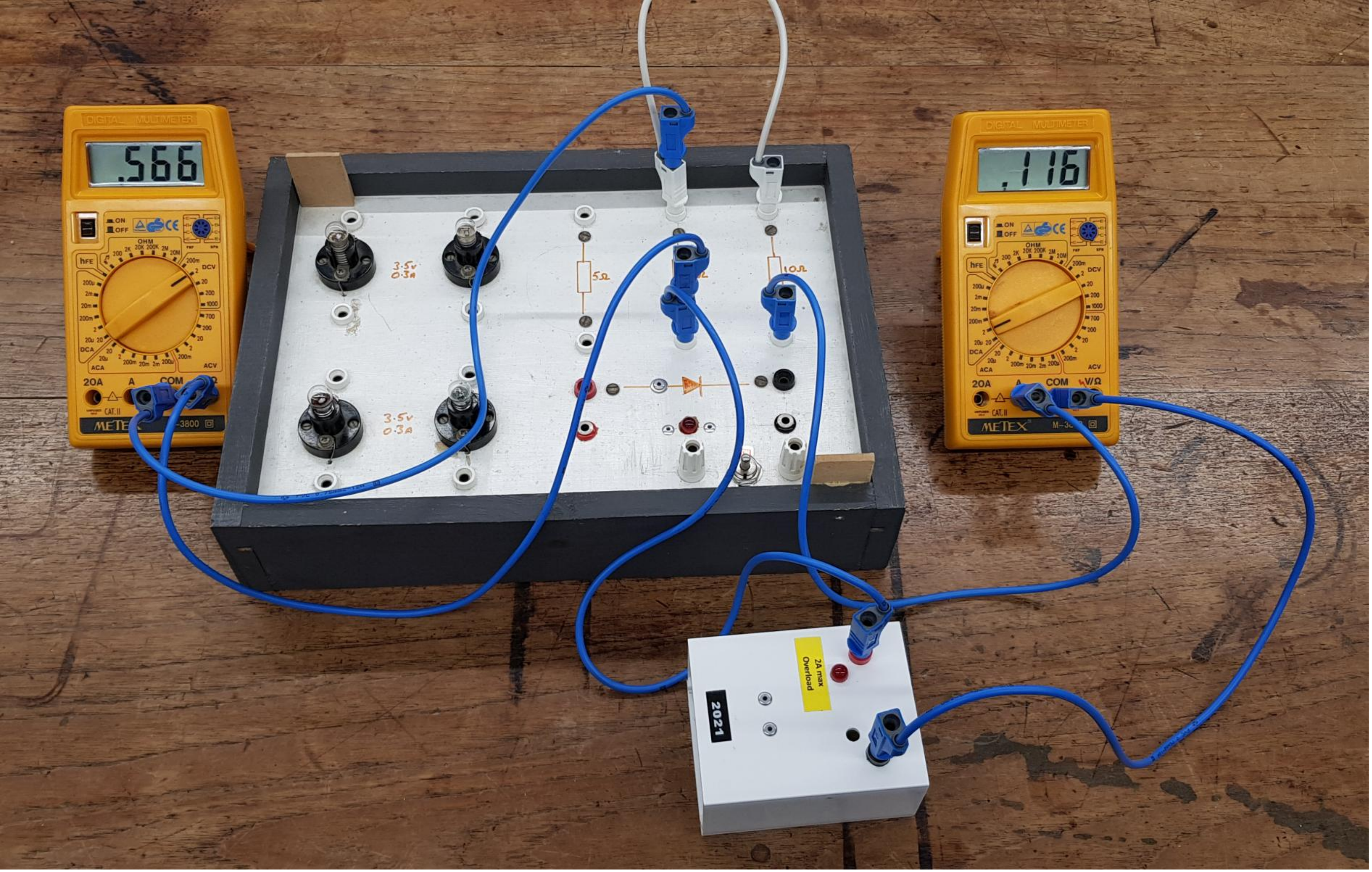


5. Connect the multimeter in **DCV** mode *in parallel **across** the **third** resistor*. Calculate the **resistance** (to 3.s.f) using $R = V / I.$ **V = ... I = ... R = ...**

6. Summarize your resistances in a **table**. You will need these numbers later!

Resistor	Resistance /ohms
R_1	
R_2	
R_3	





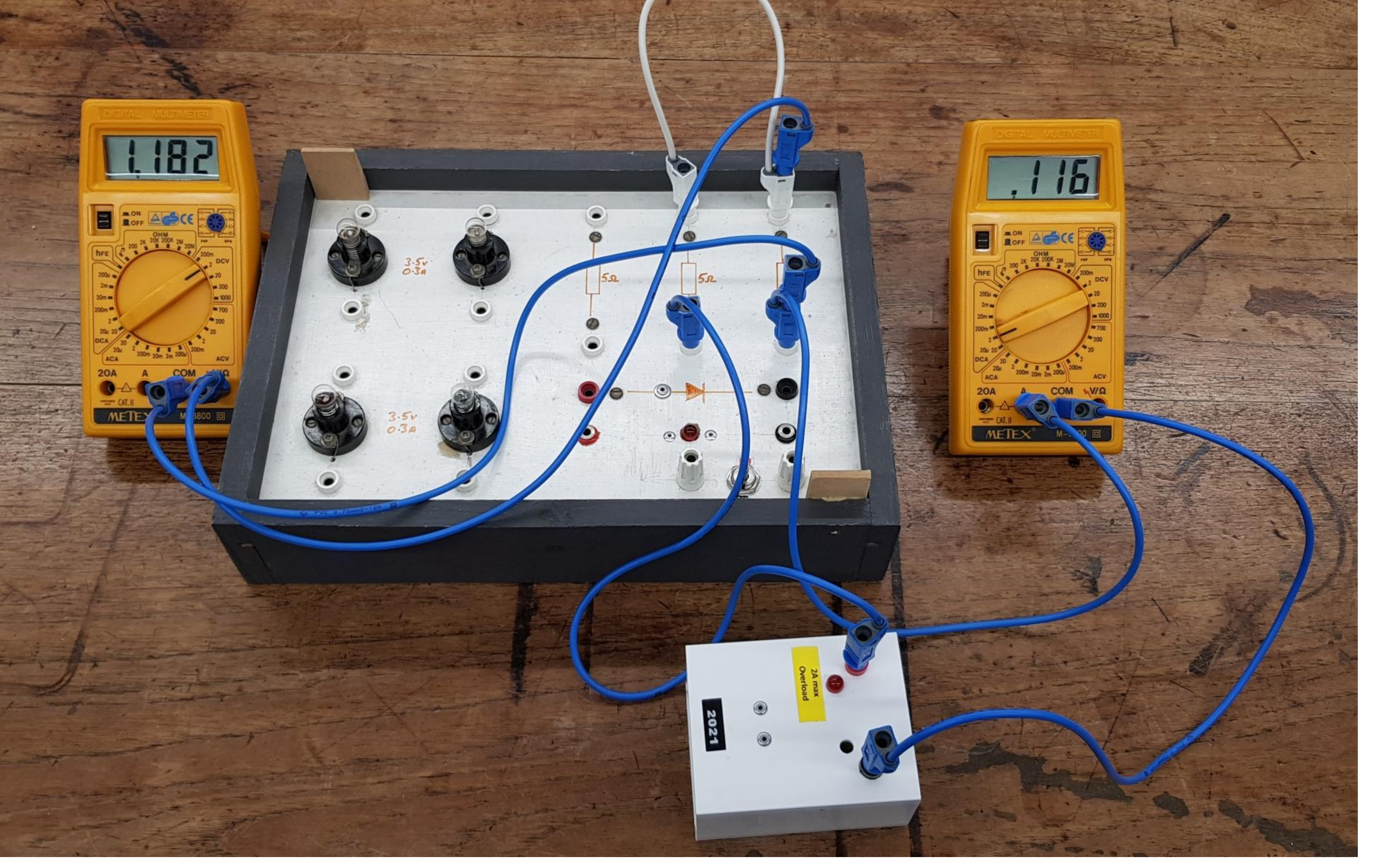
7. Now connect the *second* and *third* resistors in series.

Connect the voltmeter across the *second* resistor.

Use your calculated resistance R_2 to predict V using $V = IR$ and the measured current I

V prediction = ...

V measured = ...

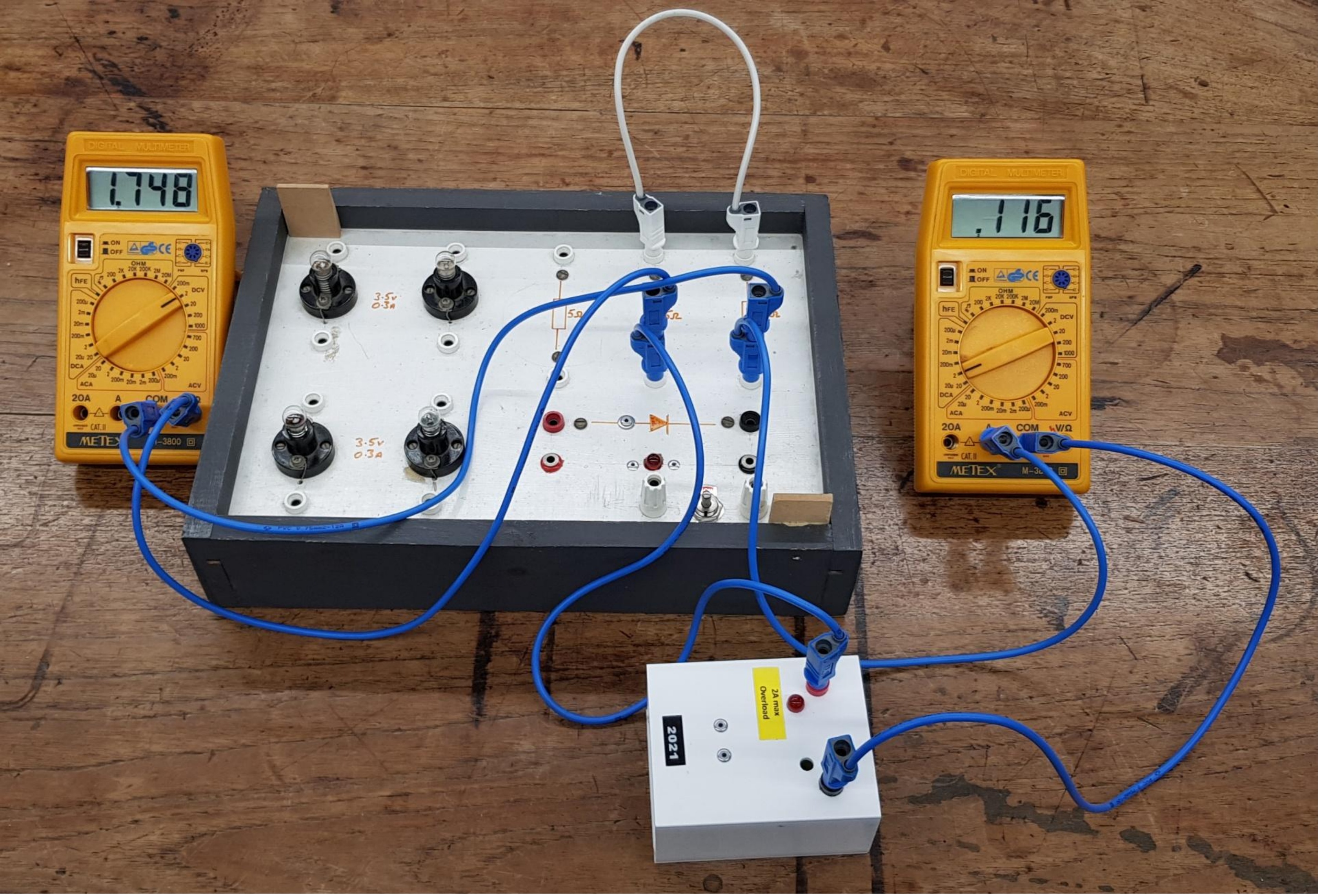


8. Use the same series connection of second and third resistors. Now connect the voltmeter across the *third* resistor.

Use your calculated resistance R_3 to predict V using $V = IR$ and the measured current I

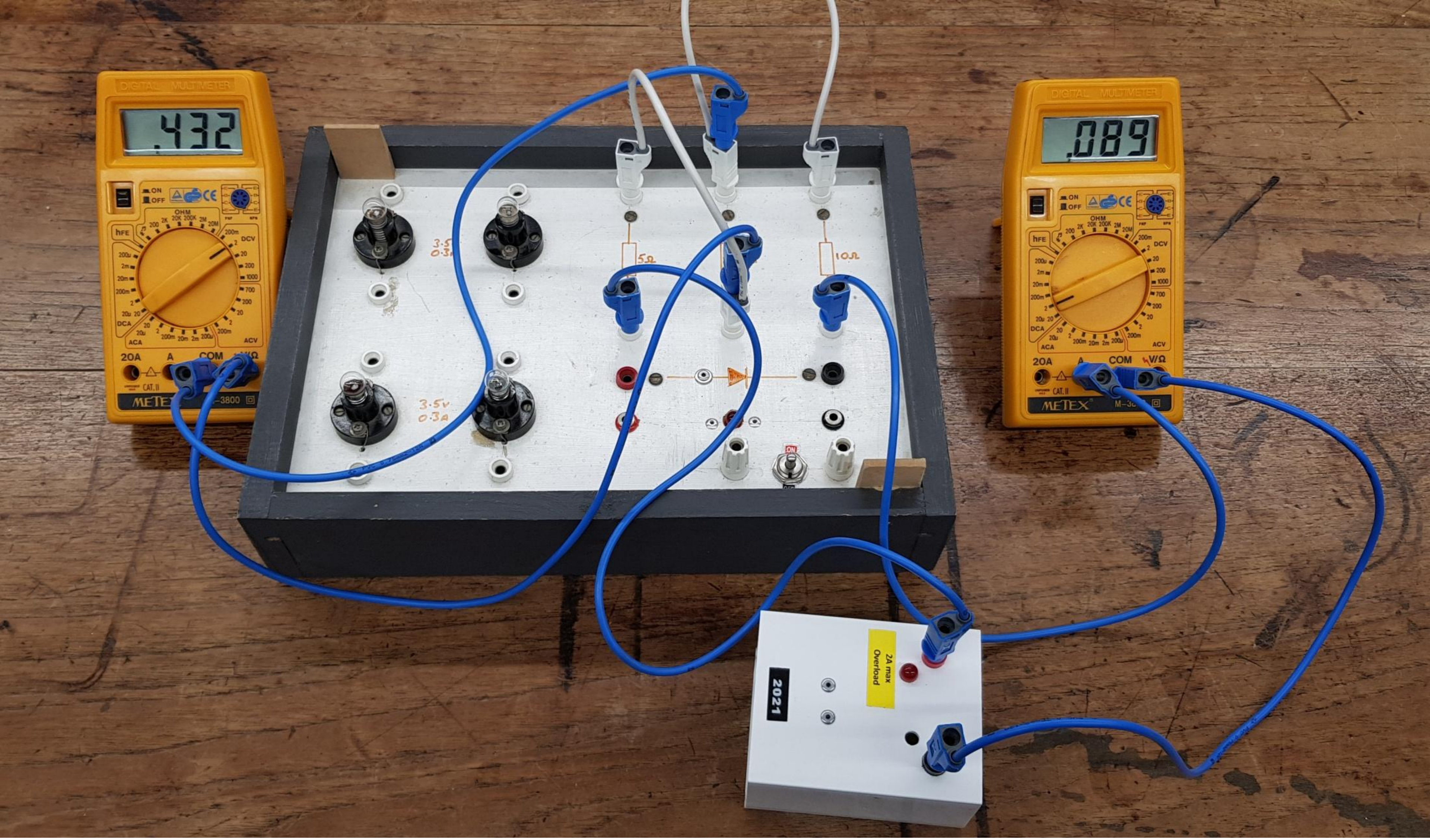
V prediction = ...

V measured = ...



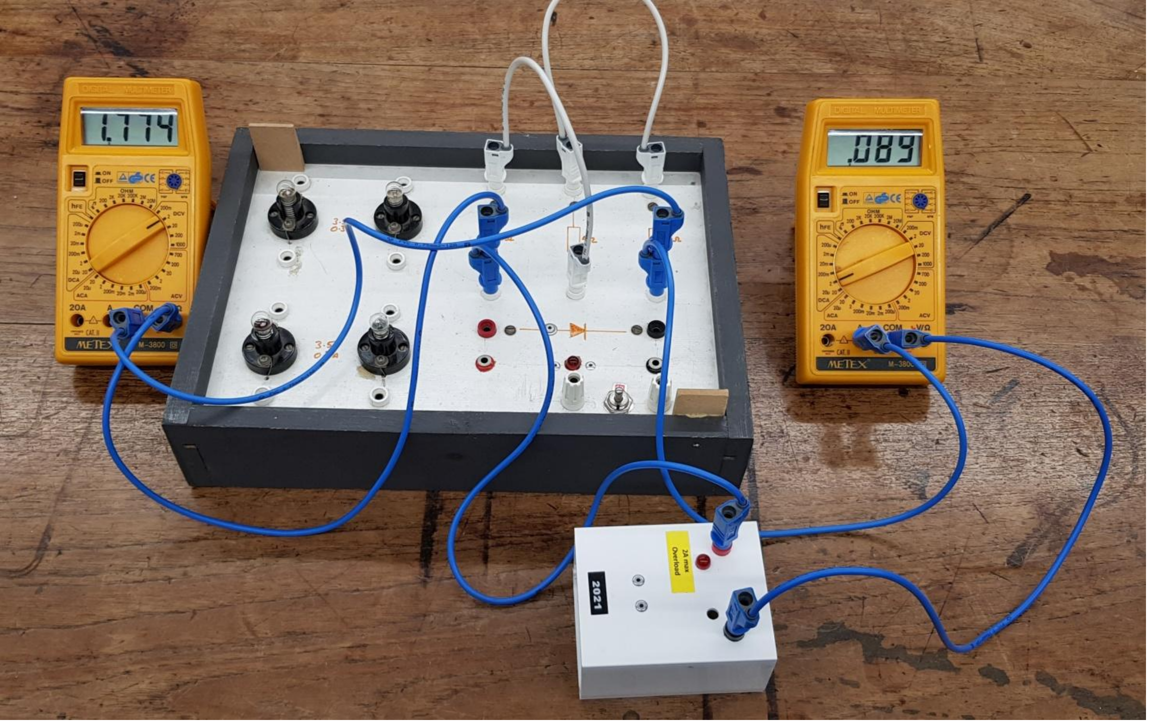
9. Now connect the voltmeter across *both* resistors R_2 and R_3. Using $R = V/I$ to calculate the total resistance. Compare this to $R_2 + R_3$

$R_2 + R_3$ = ...   TOTAL $R = V/I$ = ...



10. Now wire *all three resistors in series*. Connect the voltmeter across the second resistor.

Compare $R_2 = V/I$ = ...to your previous calculation of R_2 = ...

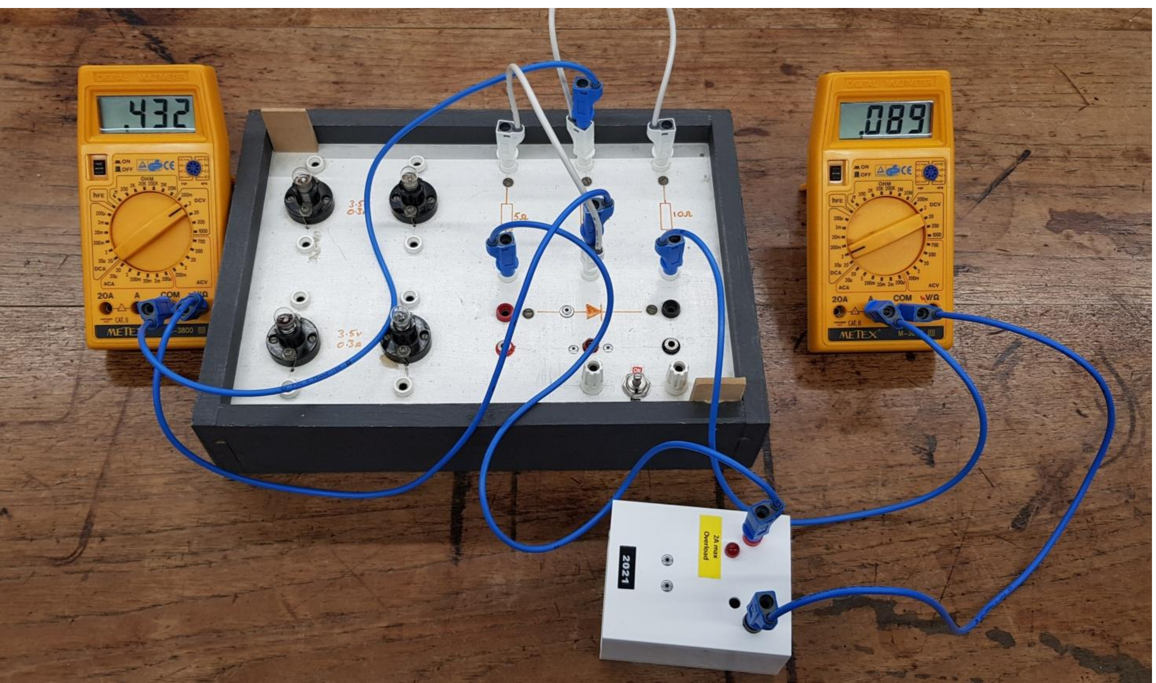


11. Connect the voltmeter across all three resistors

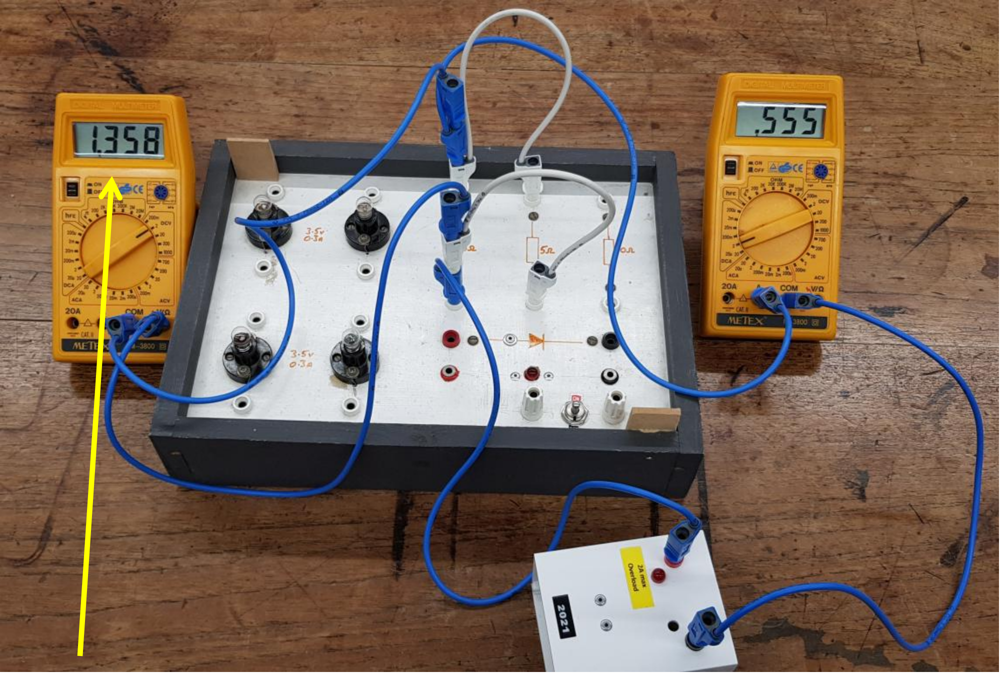
V_{123} = ...

Use the **potential divider concept** (and your measured resistances) to predict V_2, the voltage across the *second* resistor.

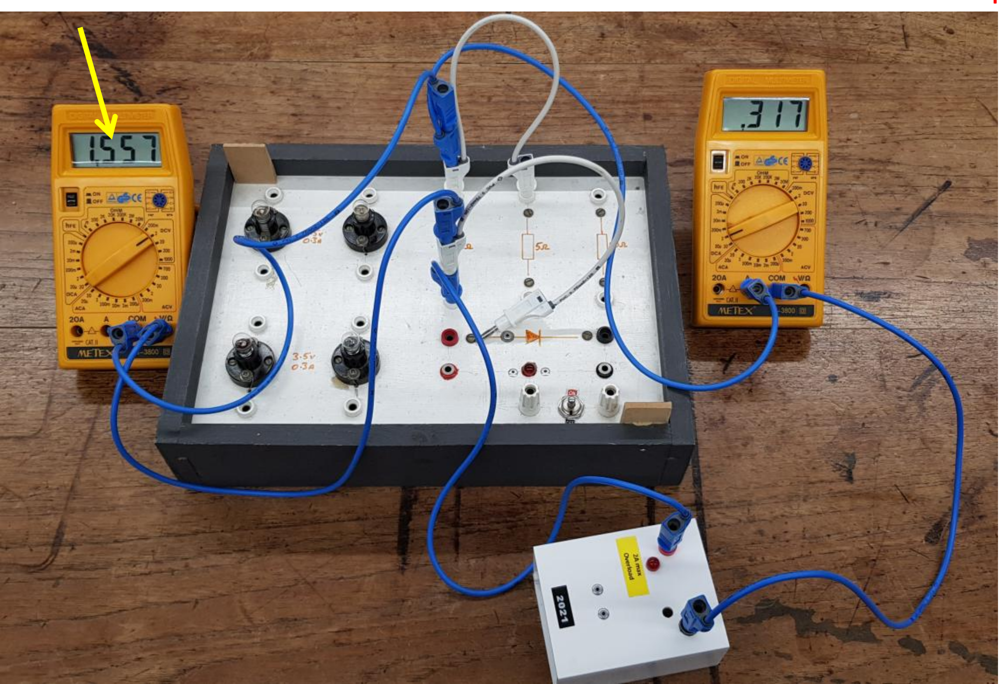
$$V_2 = V_{123} \times \frac{R_2}{R_1 + R_2 + R_3}$$



Calculations here:



Do you think we can ignore the contact resistance
of the wires sockets? What could we do to the resistances to help?



12. Now connect the first and second resistors in **parallel.**
Measure the voltage across the first, and then the second resistors.

V_1 = ...

V_2 = ...

How close are they?

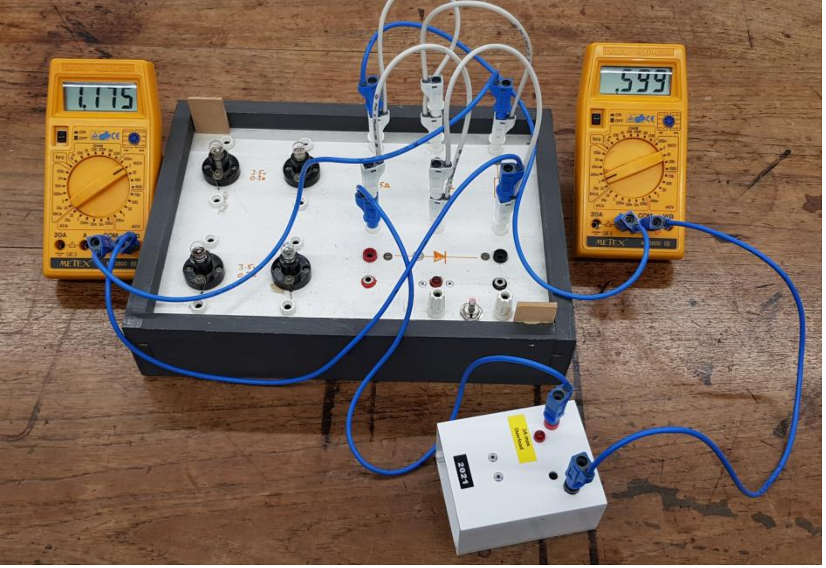
Also record the total current drawn:

I = ...

Now **disconnect** the second parallel loop and record the new current.

I = ...

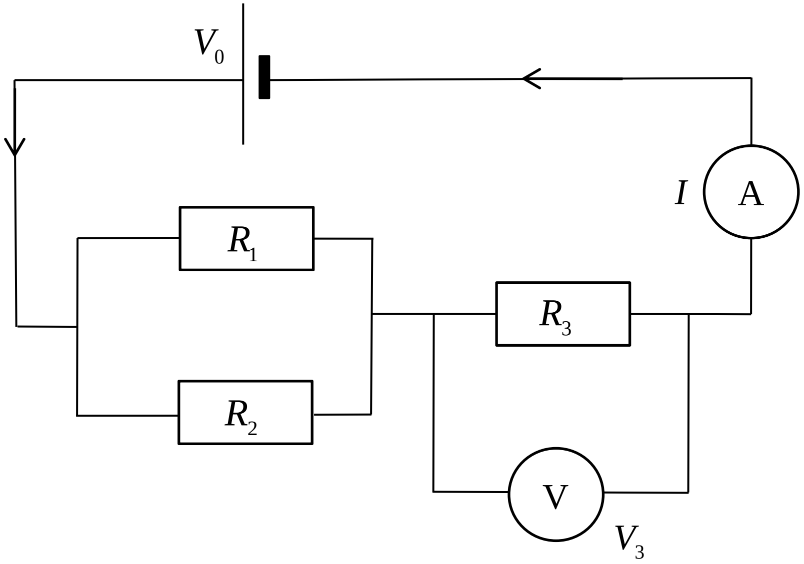
Verify if the current *difference* = V_2/R_2 i.e. the current drawn by the second parallel loop.



13. **Draw a circuit diagram** to represent the situation of **all three resistors wired in parallel.** Use $R = V/I$ to calculate the **total resistance of the circuit** from V and I measurements.

Compare your calculation of total resistance to the formula:

$$R_{total} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)^{-1}$$



14. Wire up the circuit represented on the left
Explain (via suitable annotation) why:

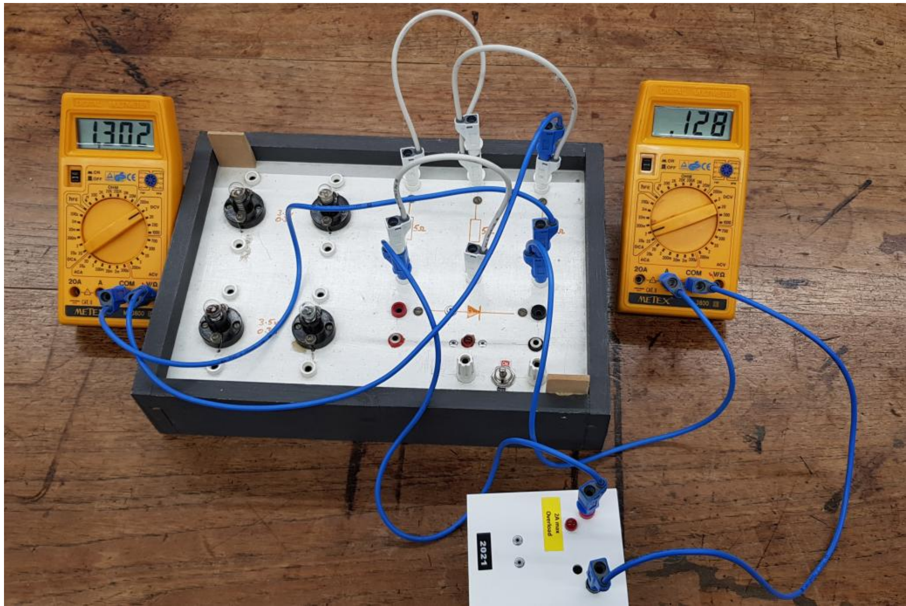
$$R_{total} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1} + R_3$$

Measure V_0 and hence predict, via the **potential divider** idea:

$$V_3 = V_0 \times \frac{R_3}{R_{total}}$$

Compare this to a direct measurement of V_3

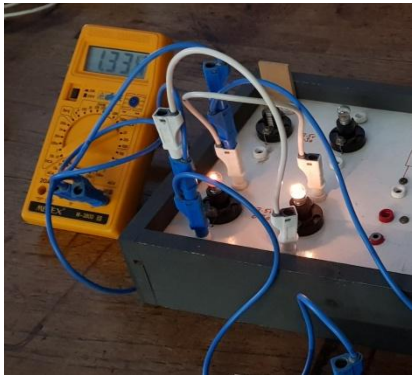
$V_3 =$ ....



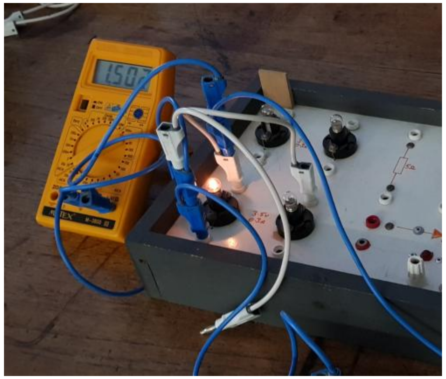
15. Now compare a wiring of two (or more) bulbs in series, *and then parallel*.
Describe and explain the ***difference*** in bulb brightness between the scenarios.

Actually do this with the circuit. Don't just comment on the photos!

Two bulbs in series



Two bulbs in parallel



One bulb in parallel

Four bulbs in parallel